MOTION OF A VISCOUS DROP WITH A MOVING CONTACT

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The motion of a viscous drop on the bottom of a parallel-walled channel is investigated numerically. A front tracking numerical method is developed to solve the two-dimensional Navier--Stokes equations within a two-phase region. The effects of density, viscosity, surface tension, gravity and contact angle on the dynamics of drop motion are illustrated. A Navier slip boundary condition is used to relax the contact line singularity. In a horizontal channel, the evolution into the steady state is computed. For a drop spreading under gravity, an instability is possible near the spreading edge of the drop when the drop density is large. We find that at low Reynolds numbers, a drop can spread monotonically into its steady state but as the Reynolds number is increased, a damped oscillation is possible. This is consistent with analytical results in the literature. When a shear flow is imposed, the dynamics are more complicated and we obtain solutions that can rupture, as well as steady state solutions.

We also study the dynamics of an axisymmetric drop. The effects of an applied flow field on the equilibrium shape of the drop are considered. If the inflow is concentrated near the center of the drop, a dry spot can occur. We show that a closing dry spot can trap a droplet of the surrounding fluid as it closes and the dynamics is dependent on the contact angle. We also consider the special situation where fluid is withdrawn above the droplet. In this case, the drop may move with the outer fluid and form a thin tip region at the top.